

U.S. Patent Application Serial No. 10/684,484
Amendment filed July 28, 2005
Reply to OA dated April 28, 2005

AMENDMENTS TO THE SPECIFICATION:

Amend the specification as follows:

Replace the paragraph beginning on page 4 line 13 with the following rewritten paragraph:

~~Figs. 2A and 2B are circuit diagrams showing an output circuit of a control unit in the photoelectric sensor~~ Figs. 2A and 2B are circuit diagrams showing output circuits in the photoelectric sensor, particularly, Fig. 2A shows an output circuit for N-channel and Fig. 2B shows an output circuit for P-channel;

Replace the paragraph beginning on page 4 line 15 with the following rewritten paragraph:

~~Fig. 3 is a timing chart showing an operation of a power supply unit of the photoelectric sensor, which~~ Figs. 3A and 3B are timing charts in the photoelectric sensor showing operations of a power supply unit and the output circuit as shown in Fig. 2A, particularly, Fig. 3A shows the relationship between a control signal output from a control unit and a driving current of a light-emitting device and Fig. 3B shows the relationship between a control signal output from a control unit and an output signal;

Replace the paragraph beginning on page 5 line 8 with the following rewritten paragraph:

Hereinafter, description will be given of a first embodiment of the present invention with reference to Figs. 1 to 4. Fig. 1 is a block diagram of a photoelectric sensor; Figs. 2A and 2B are circuit diagrams showing output circuits in the photoelectric sensor, particularly, Fig. 2A shows an output circuit for N-channel and Fig. 2B shows an output circuit for P-channel; Figs. 3A and 3B are timing charts in the photoelectric sensor showing operations of a power supply unit and the output circuit as shown in Fig. 2A, particularly, Fig. 3A an output circuit of a control unit in the photoelectric sensor, Fig. 3 is a timing chart showing an operation of a power supply unit of the photoelectric sensor, which shows the relationship between a control signal output from the control unit and a driving current of the light-emitting device: and Fig. 3B shows the relationship between a control signal output from a control unit and an output signal; and Fig. 4 is a view illustrating an object detection principle in the photoelectric sensor, which shows a detection area where a light-emitting area of a light-emitting device and a light-receiving area of a light-receiving device are overlapped with each other.

Replace the paragraph beginning on page 6 line 11 with the following rewritten paragraph:

As shown in Fig. 1, in addition to the light-emitting device 10 and the light-receiving device 20, the photoelectric sensor is configured to have: a power supply unit 40 that outputs a driving current I of the light-emitting device 10 such that its current value is variable; a control unit 30 that has the function of controlling the power supply unit 40 to change in magnitude of the driving

current I of the light-emitting device 10, and determining the presence/absence of an object based on an output from the light-receiving device 20 to output the result of determination as digital detection signals D1, D2 and D3; and an output circuit 50 that converts the detection signal D1, D2 and D3 ~~[[as]]~~ to an analog signal ~~[[to]]~~ and outputs the converted signal as a signal α . Hereinafter, description will be given of each component in detail.

Replace the paragraph beginning on page 7 line 10 with the following rewritten paragraph:

The power supply unit 40 is a circuit in which three constant-current circuits operating according to control signals OUT1, OUT2 and OUT3 output from the control unit 30 are connected in parallel. As shown in Fig. 3, when the control signals OUT1, OUT2 and OUT3 ~~are in an H level~~ at a high level (shown as "H" in Figs. 3A and 3B), the magnitude of the driving current I is changed into I1, I2 or I3.

Replace the paragraph beginning on page 8 line 16 with the following rewritten paragraph:

The output voltage of the light-emitting device 20 is input through an analog input port of the microcomputer. The output unit 32 corresponds to an I/O of the microcomputer and the configuration shown in Fig. 2A or 2B. The configuration shown in Fig. 2A is for N-channel output and the configuration shown in Fig. 2B is for P-channel output. For both circuits, ~~the detection signals D1, D2 and D3 are output, respectively;~~ when transistors Q1, Q2 and Q3 are turned on, the

detection signals D1, D2 and D3 respectively become active (active-low in the output circuit shown in FIG. 2A and active-high in the output circuit shown in Fig. 2B).

Replace the paragraph beginning on page 9 line 13 with the following rewritten paragraph:

~~As shown in Figs. 2A and 2B, when~~ When a switch ~~(not shown)~~ located outside the figure is turned on, the control unit 30 sequentially outputs the control signals OUT1, OUT2 and OUT3 as shown in Fig. 3A. At the same time, the magnitude of the driving current I output from the power supply unit 40 is increased in order of I1, I2 and I3 ~~as shown in Figs. 2A and 2B~~, and the light intensity of the light-emitting device 10 is correspondingly increased at three levels. This means that the light-emitting area of the light-emitting device 10 is substantially enlarged at three levels.

Replace the paragraph beginning on page 9 line 22 with the following rewritten paragraph:

The control unit 30 receives the output voltage of the light-receiving device 20 during outputting the control signal OUT1. When the output voltage is equal to or more than the predetermined value, as shown in Fig. 3B, the control unit 30 determines that an object passes through the detection area A1 to make the detection signal D1 active ~~and outputs the detection signal D1 at H level~~. Similarly, the control unit 30 receives the output voltage of the light-receiving device 20 during outputting the control signals OUT2 and OUT2. When the output voltage is equal to or more than the predetermined value, the control unit 30 determines that an object passes through the detection area A2 or A3 to make the detection signal D2 or D3 active ~~and outputs the detection~~

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~~signal D2 or D3 at H level.~~ Then, the output circuit 50 converts the digital value including the control signals OUT1, OUT2 and OUT3 into the analog value to output the analog signal α (see Fig. 3B).

Replace the paragraph beginning on page 10 line 12 with the following rewritten paragraph:

The above-described processing is repeatedly carried out in the control unit 30. That is, as shown in Fig. 3A, the pattern is repeated such that the light intensity of the light-emitting device 10 is increased sequentially at three levels, the light intensity is recovered to an original state, and the light intensity is increased sequentially at three levels again. Whether an object passes through the detection area A1, A2 or A3 is sequentially determined based on the output voltage of the light-receiving device 20, and the result of determination is output as the digital detection signals D1, D2 and D3 as shown in Fig. 3B. Then, the output circuit 50 converts the detection signals D1, D2 and D3 into the analog signal α to output it.

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